

31p

NASA CR-50,138

NO 68 10006

NOLC REPORT 564

1 JUNE 1962

## PROPERTIES OF PHOTODETECTORS

PHOTODETECTOR SERIES, 51ST REPORT

W. L. EISENMAN

J. D. MERRIAM

A. B. NAUGLE

RESEARCH DEPARTMENT

### OTS PRICE

XEROX

\$

MICROFILM

\$



NAVAL ORDNANCE LABORATORY CORONA

CORONA, CALIFORNIA

Code 1

# NAVAL ORDNANCE LABORATORY CORONA

W. R. KURTZ, CAPT., USN  
Commanding Officer

F. S. ATCHISON, Ph.D.  
Technical Director

## FOREWORD

This report, which was prepared as part of the Joint Services Infrared Sensitive Element Testing Program, is one of a series that consists of a collection of data sheets presenting various physical properties of photodetectors. The work reported here was performed from January to May 1962. It was authorized by WepTask RMGA-41-049/211-1/R008-03-002 and covered by the following funds:

BuWeps Allotment 52211.4  
BuShips Allotment 72174  
Air Force MIPR 33-657-2-R&D-103  
Army P. O. ERDL 4-62  
Army MIPR R-62-11-SC-00-91  
NASA WR W-11, 085-B

R. F. POTTER  
Head, Infrared Division  
Research Department

CASE FILE COPY

## CONTENTS

	<u>Page</u>
Introduction . . . . .	2
Table 1. Summary of Data . . . . .	3

### Data Sheet No.

#### Lead Selenide:

##### Eastman Kodak Company

Cell No. J621-19 . . . . .	733 . . . . .	4
J621-30 . . . . .	734 . . . . .	6
J621-48 . . . . .	735 . . . . .	8

##### Santa Barbara Research Center

Cell No. JW1278A-36 . . . . .	736 . . . . .	10
JW1295-7 . . . . .	737 . . . . .	12
4002-5-10 . . . . .	738 . . . . .	14
4002-5-13 . . . . .	739 . . . . .	16
4002-11-31 . . . . .	740 . . . . .	18

#### Indium Antimonide:

##### Philco Corporation

Cell No. [1] . . . . .	741 . . . . .	20
[2] . . . . .	742 . . . . .	22

#### Golay detector:

##### Eppley Laboratory, Inc.

Cell No. 786 . . . . .	743 . . . . .	24
------------------------	---------------	----

#### Thermocouple:

##### Perkin Elmer Corporation

Cell No. 9770 . . . . .	744 . . . . .	26
-------------------------	---------------	----

Appendix: Definitions of Symbols and Terms . . . . .	28
--	----

## INTRODUCTION

16668

This report presents the results of measurements made on twelve photodetectors. It includes data sheets on lead selenide cells from the Eastman Kodak Company and the Santa Barbara Research Center; indium antimonide cells from the Philco Corporation; a Golay detector cell from the Eppley Laboratory, Inc.; and a thermocouple cell from the Perkin Elmer Corporation.

It will be noted that tests conducted on the Golay detector and the thermocouple cells deviated from the normal procedure in that the blackbody response was measured at 500, 10 rather than the usual 500, 90.

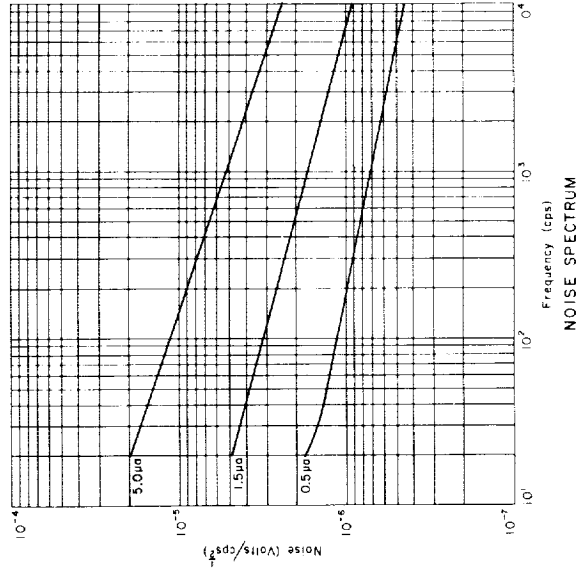
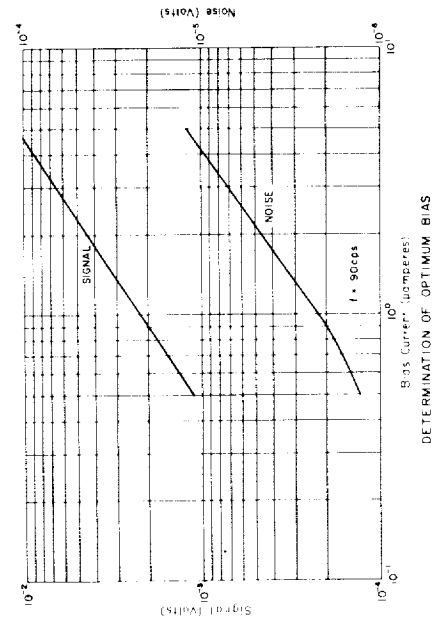
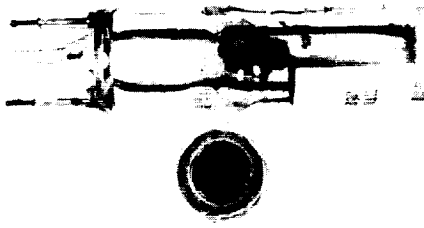
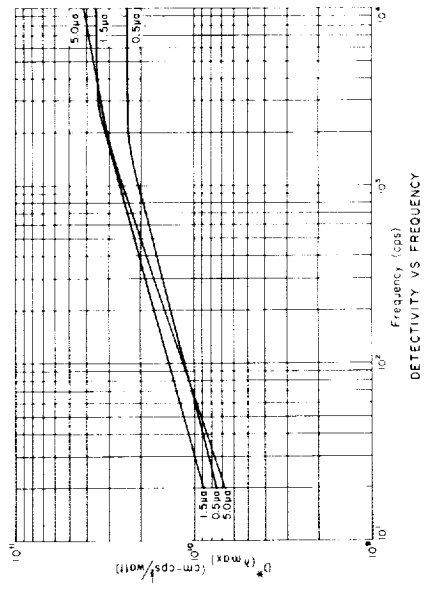
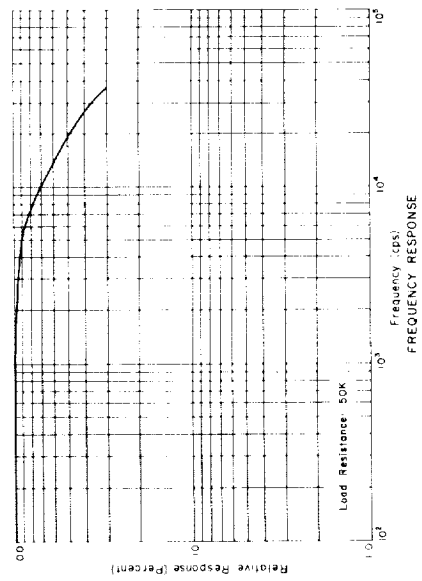
A summary of the data obtained is given in Table 1.

TABLE I. Summary of Data

Data sheet No.	Cell type	Cell No. <sup>1</sup>	Area (cm <sup>2</sup> )	Cell temp. (K)	Blackbody response (500, 90)					$R \sqrt{\frac{R_{bb}}{R_{bb}}}$	Peak wave-length (μ)	Peak detective modulation frequency (cps)	D* <sup>mm</sup> (cm·cps <sup>1/2</sup> /watt)
					$R_i$ responsivity (volts/watt)	$H_N$ noise equivalent irradiance (watts/(cps <sup>1/2</sup> ·cm <sup>2</sup> ))	P.N. noise equivalent power (watts/cps <sup>1/2</sup> )	D* (cm·cps <sup>1/2</sup> /watt)	Responsive time constant (μsec)				
733	PbSe (evaporated)	EK J621-19	$6.3 \times 10^{-3}$	193	$6.0 \times 10^4$	$9.3 \times 10^{-9}$	$5.8 \times 10^{-11}$	$1.4 \times 10^9$	16	9.3	2.0	$1 \times 10^4$	$4.1 \times 10^{10}$
734	PbSe (evaporated)	EK J621-30	$6.3 \times 10^{-3}$	197	$4.6 \times 10^4$	$5.9 \times 10^{-9}$	$3.7 \times 10^{-11}$	$2.1 \times 10^9$	28	9.1	2.2	$1 \times 10^4$	$3.8 \times 10^{10}$
735	PbSe (evaporated)	EK J621-48	$6.3 \times 10^{-3}$	197	$4.1 \times 10^4$	$8.8 \times 10^{-9}$	$5.6 \times 10^{-11}$	$1.4 \times 10^9$	26	9.1	2.2	$4 \times 10^3$	$2.8 \times 10^{10}$
736	PbSe (chemical)	SBRC JW1278A-36	$6.3 \times 10^{-4}$	78	$1.8 \times 10^6$	$6.0 \times 10^{-9}$	$3.8 \times 10^{-12}$	$6.6 \times 10^9$	42	3.9	4.1	$> 4 \times 10^3$	$4.1 \times 10^{10}$
737	PbSe (chemical)	SBRC JW1295-7	$6.3 \times 10^{-2}$	78	$1.3 \times 10^5$	$6.2 \times 10^{-10}$	$3.9 \times 10^{-11}$	$6.4 \times 10^9$	$1.4 \times 10^2$	4.1	4.1	$> 4 \times 10^3$	$3.3 \times 10^{10}$
738	PbSe (chemical)	SBRC 4002-5-10	$6.3 \times 10^{-2}$	78	$2.4 \times 10^5$	$5.4 \times 10^{-10}$	$3.3 \times 10^{-11}$	$7.5 \times 10^9$	84	4.1	4.3	$> 4 \times 10^3$	$4.5 \times 10^{10}$
739	PbSe (chemical)	SBRC 4002-5-13	$6.3 \times 10^{-2}$	78	$2.5 \times 10^5$	$5.5 \times 10^{-10}$	$3.4 \times 10^{-11}$	$7.3 \times 10^9$	85	3.9	4.0	$> 4 \times 10^3$	$4.3 \times 10^{10}$
740	PbSe (chemical)	SBRC 4002-11-31	$6.3 \times 10^{-4}$	78	$5.8 \times 10^5$	$9.7 \times 10^{-9}$	$6.0 \times 10^{-12}$	$4.2 \times 10^9$	72	4.4	4.3	$> 2 \times 10^3$	$2.1 \times 10^{10}$
741	InSb (crystal)	PC [1]	$5.5 \times 10^{-2}$	78	$6.3 \times 10^3$	$4.7 \times 10^{-10}$	$2.6 \times 10^{-11}$	$9.1 \times 10^9$	39	5.3	4.8	$> 10^3$	$8.3 \times 10^{10}$
742	InSb (crystal)	PC [2]	$3.5 \times 10^{-2}$	78	$8.4 \times 10^3$	$5.7 \times 10^{-10}$	$2.0 \times 10^{-11}$	$9.3 \times 10^9$	57	5.3	4.8	$> 10^3$	$8.3 \times 10^{10}$
743	Golay detector (pneumatic)	EL 786	$7.1 \times 10^{-1}$	297	$1.5 \times 10^2$ <sup>†</sup>	$1.5 \times 10^{-8}$ <sup>†</sup>	$1.1 \times 10^{-8}$ <sup>†</sup>	$7.7 \times 10^7$ <sup>†</sup>	$5.7 \times 10^3$	16	0.8	$1 \times 10^1$	$1.2 \times 10^9$
744	Thermocouple	PE 9770	$4 \times 10^{-3}$	297	$3.0$ <sup>†</sup>	$4.5 \times 10^{-8}$ <sup>†</sup>	$1.8 \times 10^{-10}$ <sup>†</sup>	$3.5 \times 10^8$ <sup>†</sup>	$1.9 \times 10^4$	1.2	1.0	1.0	$9.1 \times 10^8$

<sup>1</sup> Abbreviations: EK—Eastman Kodak Co.; SBRC—Santa Barbara Research Center; PC—Philco Corporation; EL—Eppley Laboratory, Inc.; PE—Perkin Elmer Corporation.

<sup>†</sup> Blackbody response measured at 500, 10.



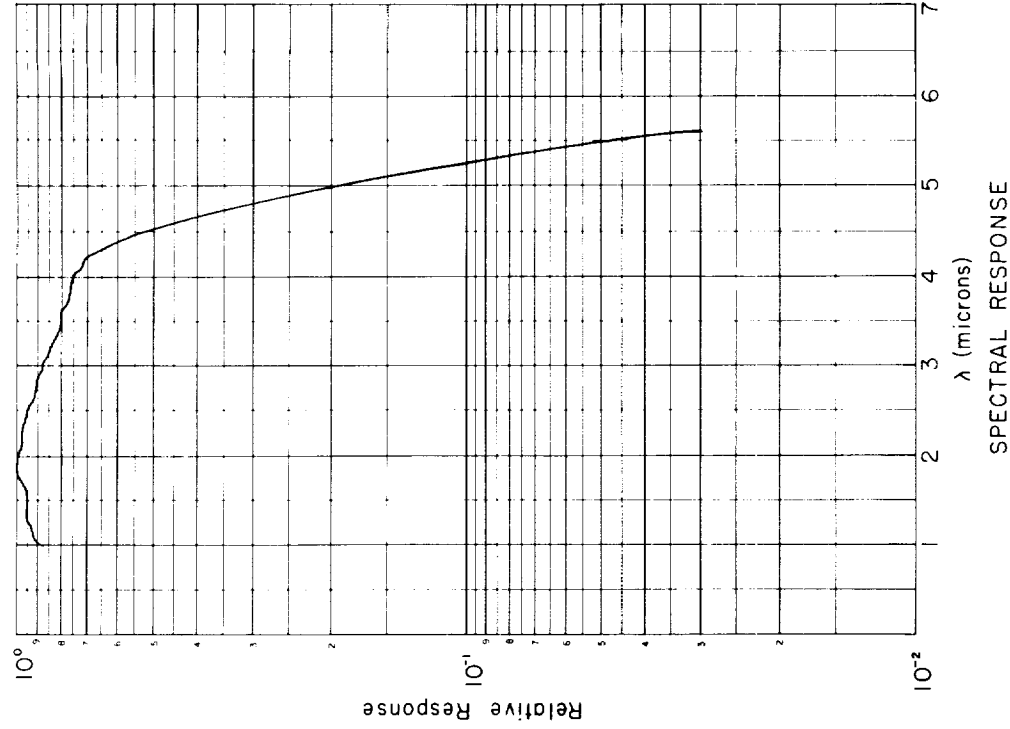
Eastman Kodak Co., Cell J621-19, PbSe  
DATA SHEET NO. 733-A—January 1962

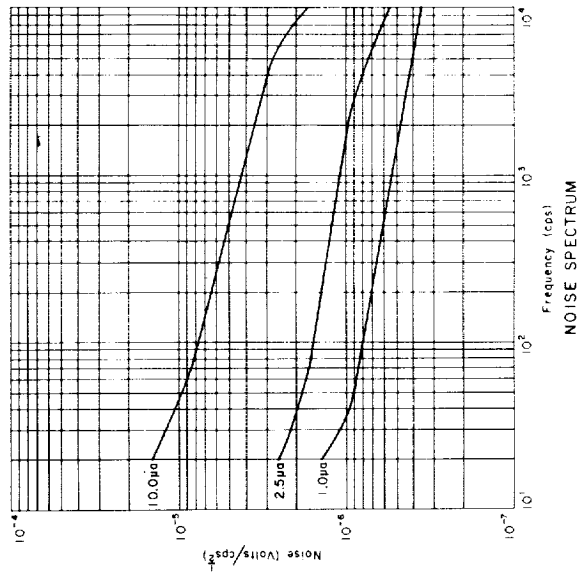
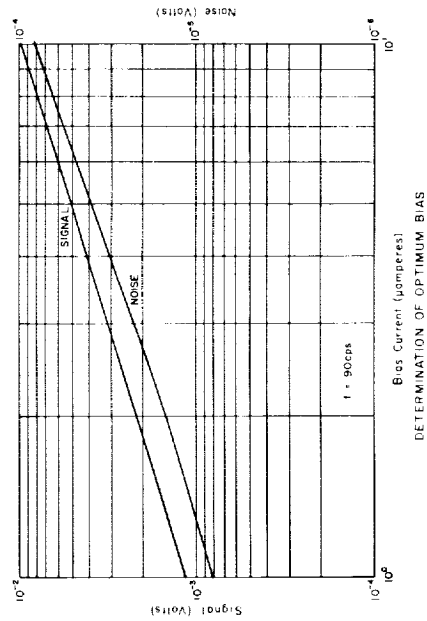
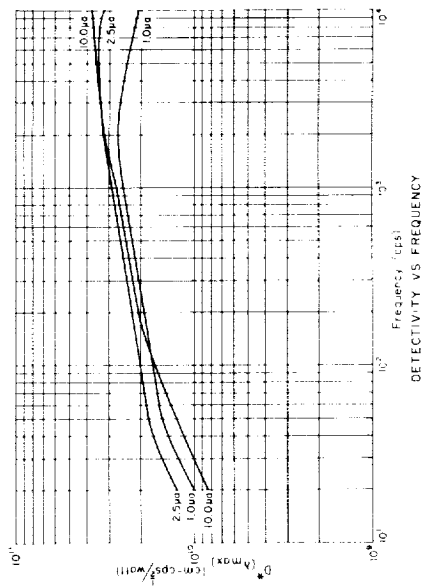
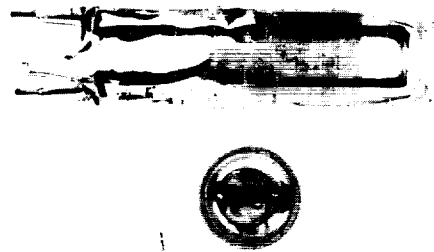
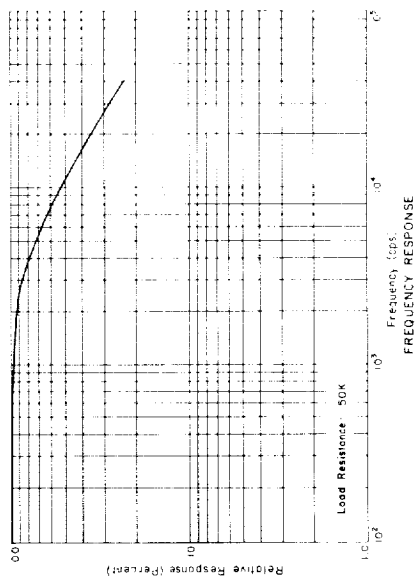
# TEST RESULTS

R (volts/watt) (500, 90)	$6.0 \times 10^{-1}$	Blackbody temperature (°K)	500
H <sub>N</sub> (watts/cps <sup>1/2</sup> ·cm <sup>2</sup> ) (500, 90)	$9.1 \times 10^{-9}$	Blackbody flux density (μwatts/cm <sup>2</sup> , rms)	9.0
P <sub>N</sub> (watts/cps <sup>1/2</sup> ) (500, 90)	$5.8 \times 10^{-11}$	Chopping frequency (cps)	90
D* (cm·cps <sup>1/2</sup> /watt) (500, 90)	$1.4 \times 10^9$	Noise bandwidth (cps)	5
Responsive time constant (μsec)	16	Cell temperature (°K)	193
$\frac{R_{\lambda\max}}{R_{bb}}$	9.3	Cell current for 90-cps data (μa)	1.5
Peak wavelength (μ)	2.0	Cell current for D* mm (μa)	5.0
Peak detective modulation frequency (cps)	$10^4$	Load resistance (ohms)	$5.0 \times 10^6$
D* mm (cm·cps <sup>1/2</sup> /watt)	$4.1 \times 10^{10}$	Transformer	---
		Relative humidity (%)	15
		Responsive plane (from window)	---
		Ambient temperature (°C)	24
		Ambient radiation on detector	297°K only

# CELL DESCRIPTION

Type	PbSe (evap.)
Shape of sensitive area (cm)	$0.038 \times 0.166$
Area (cm <sup>2</sup> )	$6.3 \times 10^{-5}$
Dark resistance (ohms)	$6.7 \times 10^9$
Dynamic resistance (ohms)	---
Field of view	---
Window material	Sapphire



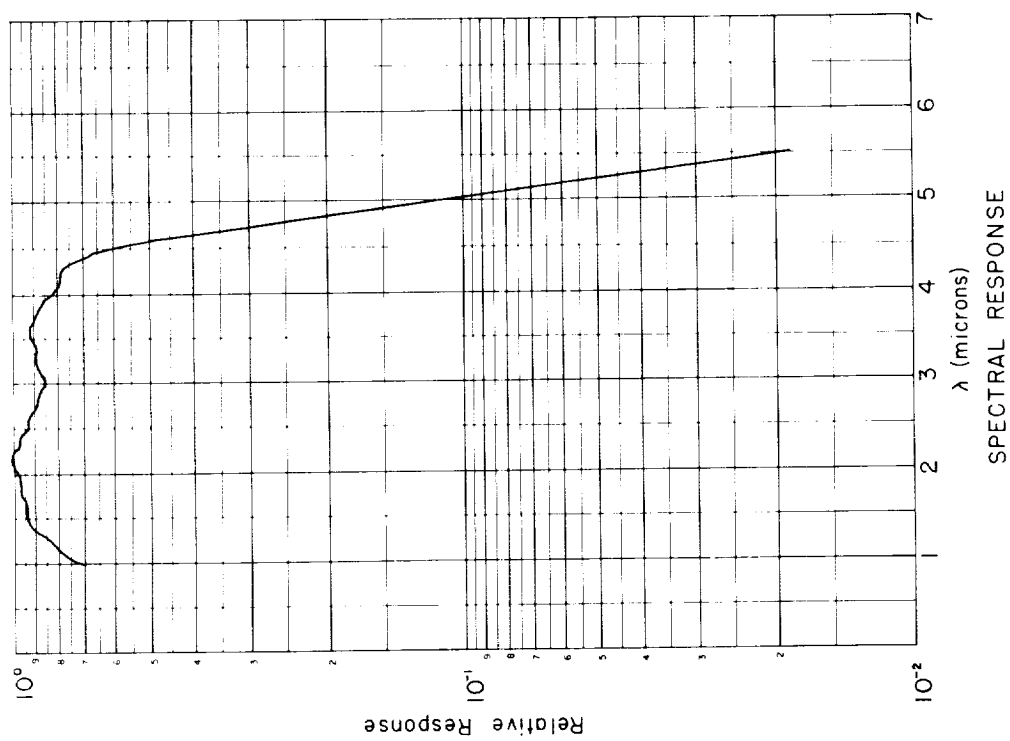


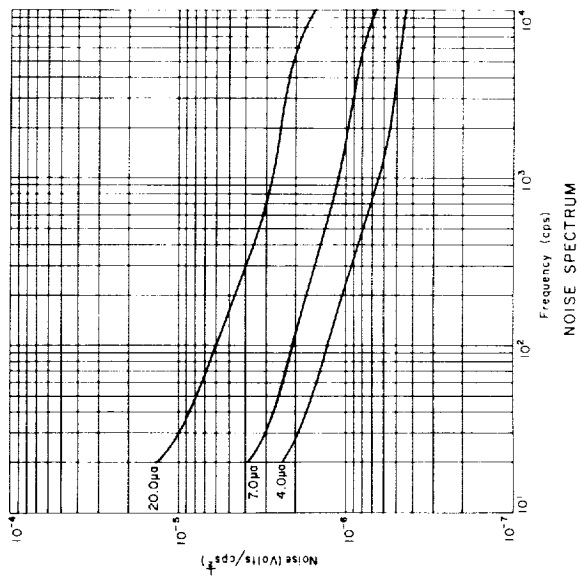
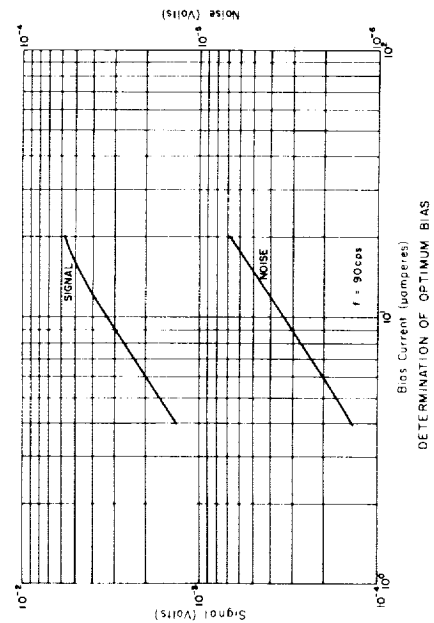
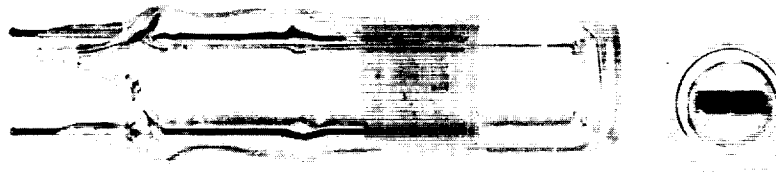
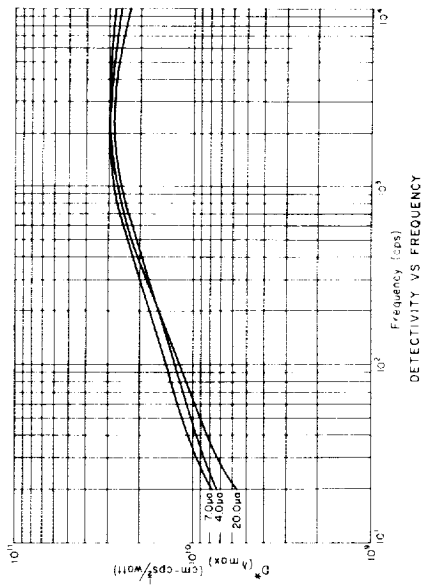
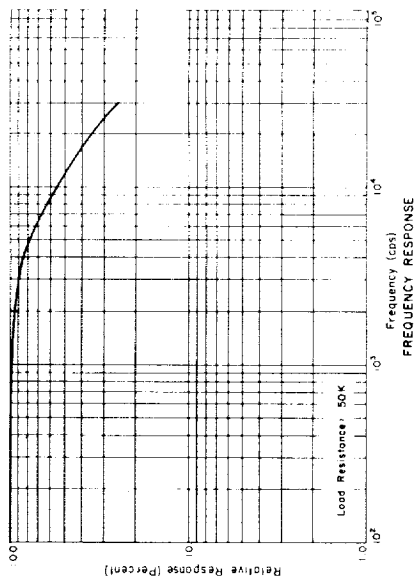
TEST RESULTS

R (volts/watt) (500, 90)	$4.6 \times 10^{-4}$	Blackbody temperature (°K)	500
H <sub>N</sub> (watts/cps <sup>1/2</sup> ·cm <sup>2</sup> ) (500, 90)	$5.9 \times 10^{-9}$	Blackbody flux density (μwatts/cm <sup>2</sup> , rms)	9.0
P <sub>N</sub> (watts/cps <sup>1/2</sup> ) (500, 90)	$3.7 \times 10^{-11}$	Chopping frequency (cps)	90
D* (cm·cps <sup>1/2</sup> /watt) (500, 90)	$2.1 \times 10^9$	Noise bandwidth (cps)	5
Responsive time constant (μsec)	28	Cell temperature (°K)	197
$\frac{R_{\lambda\text{max}}}{R_{\text{bb}}}$	9.1	Cell current for 90-cps data (μa)	2.5
Peak wavelength (μ)	2.2	Cell current for D* mm (μa)	10.0
Peak detective modulation frequency (cps)	10 <sup>4</sup>	Load resistance (ohms)	$2.5 \times 10^6$
D* mm (cm·cps <sup>1/2</sup> /watt)	$3.8 \times 10^{10}$	Transformer	---
		Relative humidity (%)	26
		Responsive plane (from window)	---
		Ambient temperature (°C)	24
		Ambient radiation on detector	297 K only

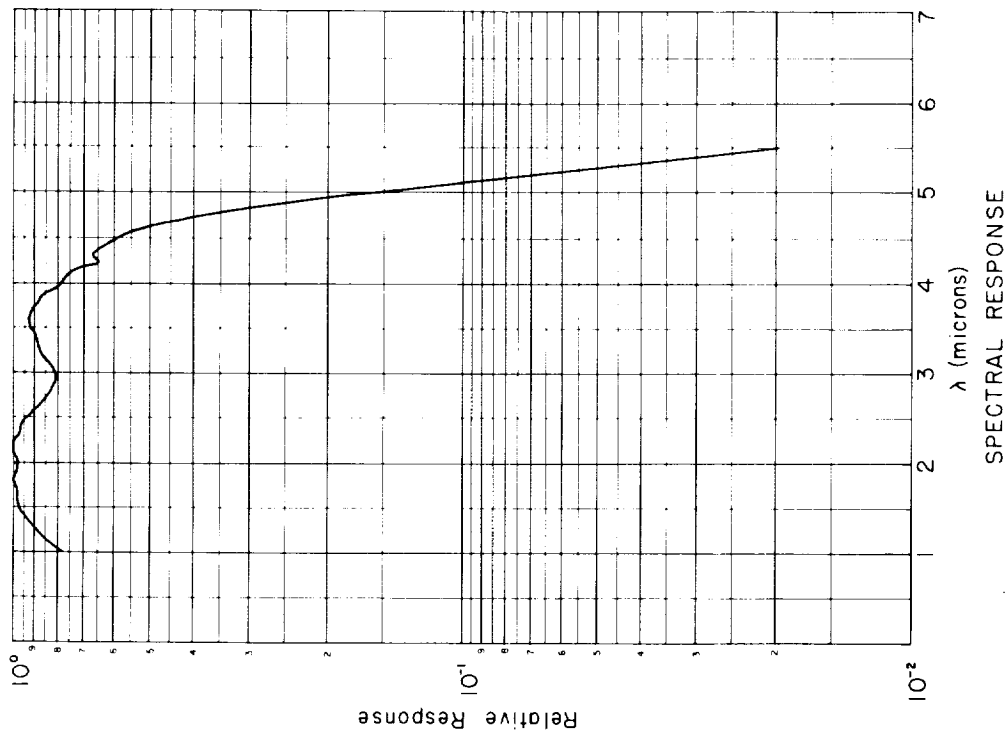
CELL DESCRIPTION

Type	PbSe (evap.)
Shape of sensitive area (cm)	$0.078 \times 0.116$
Area (cm <sup>2</sup> )	$6.5 \times 10^{-4}$
Dark resistance (ohms)	$4.1 \times 10^6$
Dynamic resistance (ohms)	---
Field of view	---
Window material	Sapphire

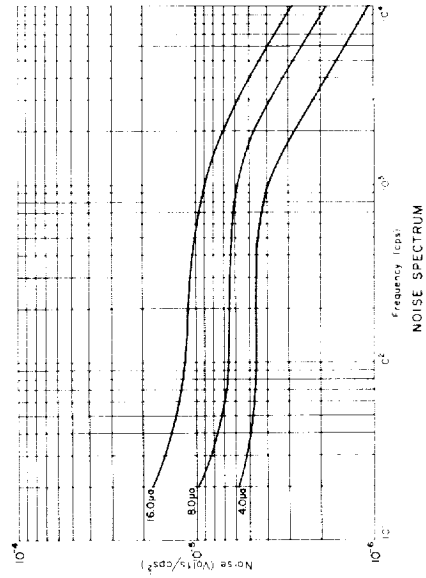
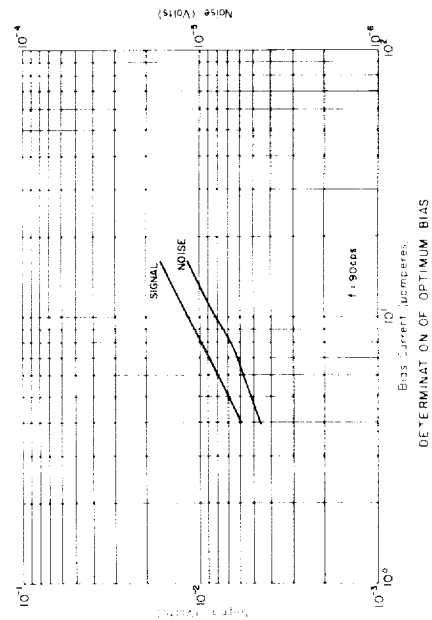
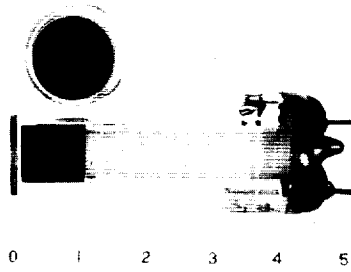
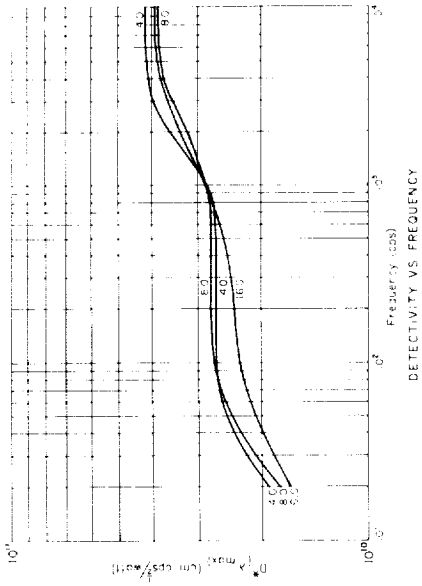
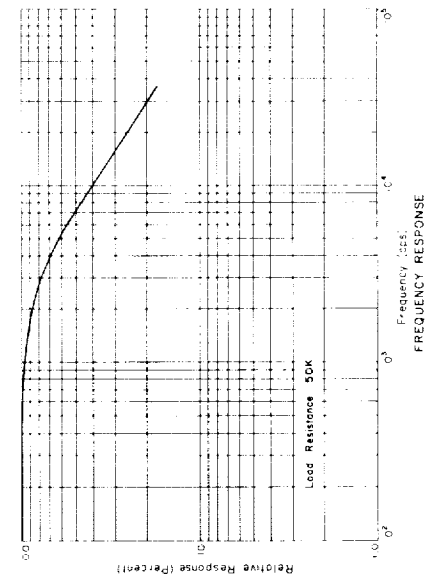




TEST RESULTS		CONDITIONS OF MEASUREMENT	
R (volts/watt) (500, 90)	$4.1 \times 10^{-4}$	Blackbody temperature (°K)	500
H <sub>N</sub> (watts/cps <sup>1/2</sup> ·cm <sup>2</sup> ) (500, 90)	$5.8 \times 10^{-9}$	Blackbody flux density (μwatts/cm <sup>2</sup> , rms)	9.0
P <sub>N</sub> (watts/cps <sup>1/2</sup> ) (500, 90)	$5.6 \times 10^{-11}$	Chopping frequency (cps)	90
D* (cm-cps <sup>1/2</sup> /watt) (500, 90)	$1.4 \times 10^9$	Noise bandwidth (cps)	5
Responsive time constant (μsec)	26	Cell temperature (°K)	197
$\frac{R_{\lambda\max}}{R_{bb}}$	9.1	Cell current for 90-cps data (μa)	7.0
Peak wavelength (μ)	2.2	Cell current for D* mm (μa)	20.0
Peak detective modulation frequency (cps)	$4 \times 10^3$	Load resistance (ohms)	$2.5 \times 10^6$
D* mm (cm-cps <sup>1/2</sup> /watt)	$2.8 \times 10^{10}$	Transformer	---
CELL DESCRIPTION		Relative humidity (%)	16
Type	PbSe (evap.)	Responsive plane (from window)	---
Shape of sensitive area (cm)	$0.048 \times 0.168$	Ambient temperature (°C)	24
Area (cm <sup>2</sup> )	$6.3 \times 10^{-3}$	Ambient radiation on detector	297 K only
Dark resistance (ohms)	$1.64 \times 10^6$		
Dynamic resistance (ohms)	---		
Field of view	---		
Window material	Sapphire		

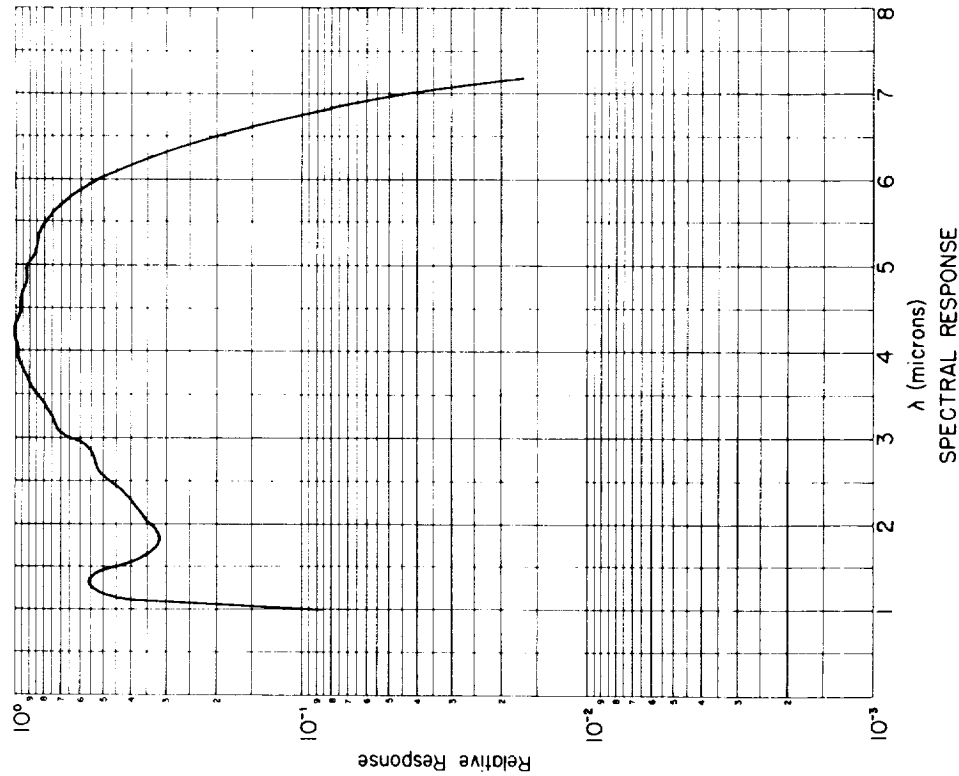


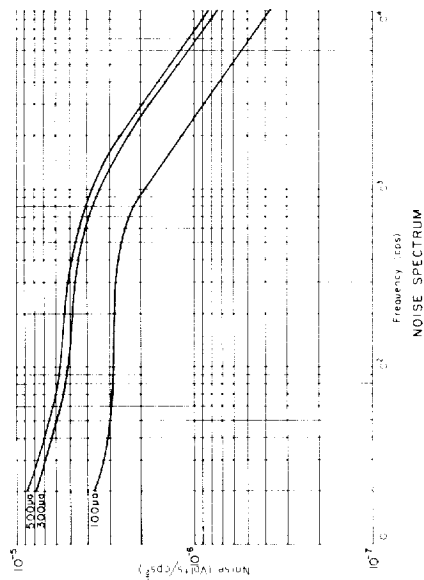
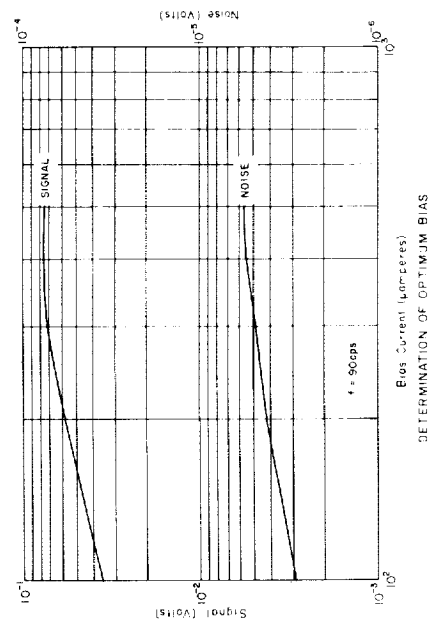
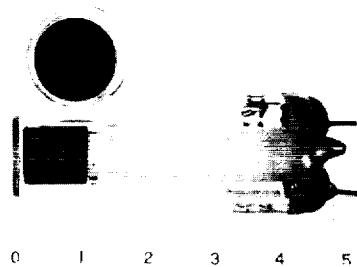
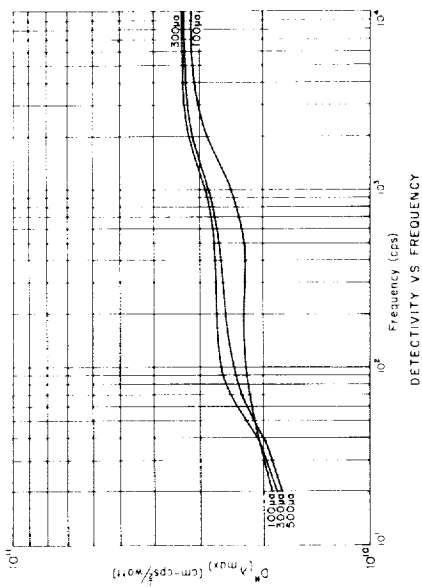
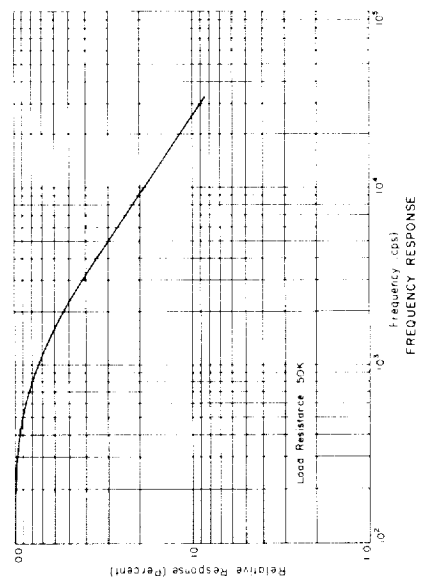
Eastman Kodak Co., Cell J621-48, PbSe  
DATA SHEET NO. 735-B—January 1962

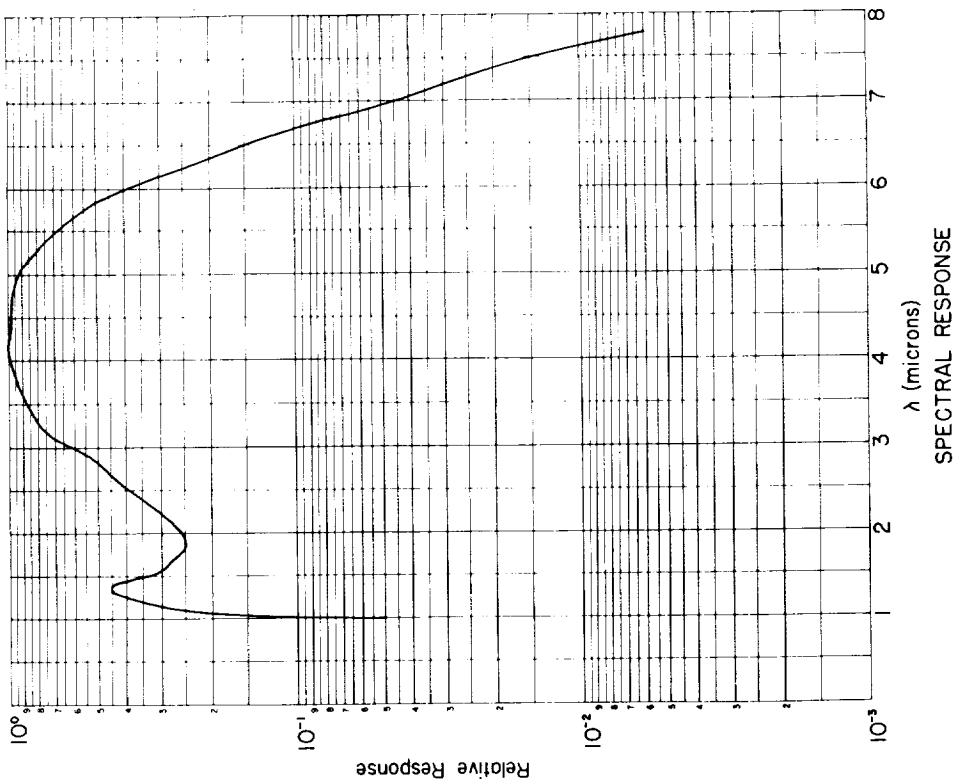


# TEST RESULTS

R (volts/watt) (500, 90)	$1.8 \times 10^6$	Blackbody temperature (*K)	500
H <sub>N</sub> (watts/cps <sup>1/2</sup> .cm <sup>2</sup> ) (500, 90)	$6.0 \times 10^{-9}$	Blackbody flux density (μwatts/cm <sup>2</sup> , rms)	9.0
P <sub>N</sub> (watts/cps <sup>1/2</sup> ) (500, 90)	$3.8 \times 10^{-12}$	Chopping frequency (cps)	90
D* (cm-cps <sup>1/2</sup> /watt) (500, 90)	$6.6 \times 10^9$	Noise bandwidth (cps)	5
Responsive time constant (μsec)	4.2	Cell temperature (*K)	78
$\frac{R_{\lambda\max}}{R_{bb}}$	3.9	Cell current for 90-cps data (μa)	8.0
Peak wavelength (μ)	4.1	Cell current for D* mm (μa)	4.0
Peak detective modulation frequency (cps)	$> 4 \times 10^3$	Load resistance (ohms)	$2.5 \times 10^6$
D* mm (cm-cps <sup>1/2</sup> /watt)	$4.1 \times 10^{10}$	Transformer	---
		Relative humidity (%)	32
		Responsive plane (from window)	---
		Ambient temperature (*C)	23
		Ambient radiation on detector	297° K only
Type	PbSe (chem.)		
Shape of sensitive area (cm)	$0.025 \times 0.025$		
Area (cm <sup>2</sup> )	$6.25 \times 10^{-4}$		
Dark resistance (ohms)	$3.5 \times 10^6$		
Dynamic resistance (ohms)	---		
Field of view	90°		
Window material	Silicon (coated)		







# CONDITIONS OF MEASUREMENT

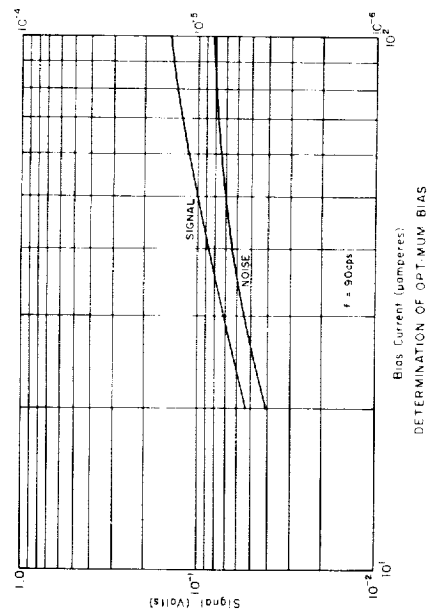
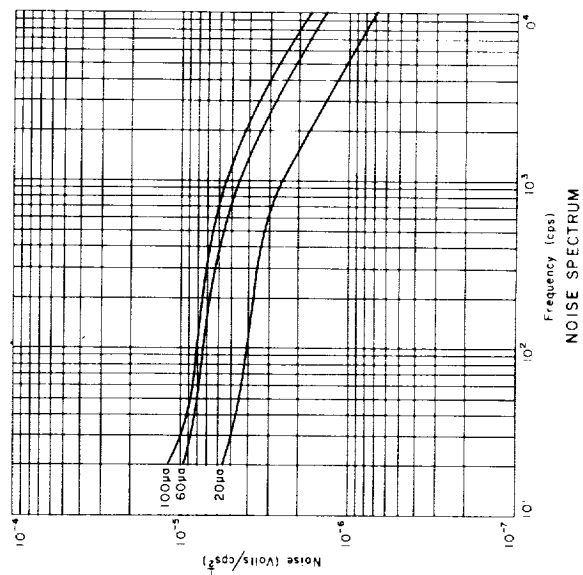
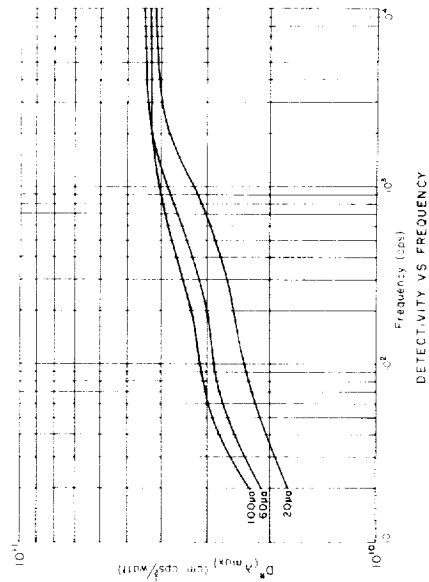
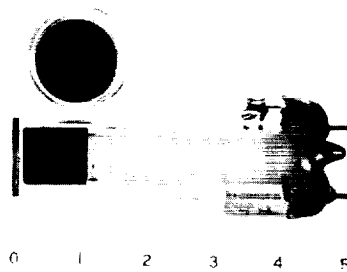
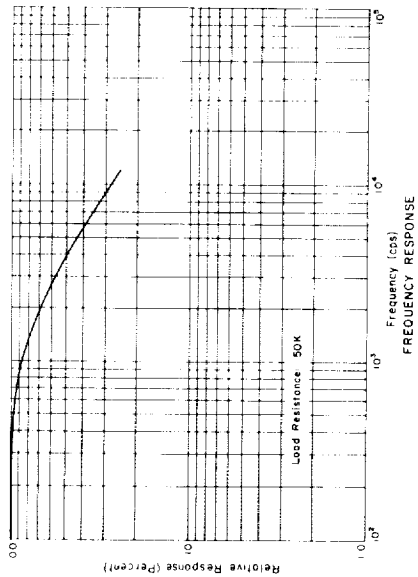
Blackbody temperature (°K)	500
Blackbody flux density (μwatts/cm <sup>2</sup> , rms)	4.0
Chopping frequency (cps)	90
Noise bandwidth (cps)	5
Cell temperature (°K)	78
Cell current for 90-cps data (μa)	300
Cell current for D* <sub>nm</sub> (μa)	300
Load resistance (ohms)	5 × 10 <sup>5</sup>
Transformer	---
Relative humidity (%)	34
Responsive plane (from window)	---
Ambient temperature (°C)	23
Ambient radiation on detector	296°K

# TEST RESULTS

R (volts/watt) (500, 90)	1.3 × 10 <sup>-5</sup>
H <sub>N</sub> (watts/cps <sup>1/2</sup> ·cm <sup>2</sup> ) (500, 90)	6.2 × 10 <sup>-10</sup>
P <sub>N</sub> (watts/cps <sup>1/2</sup> ) (500, 90)	3.9 × 10 <sup>-11</sup>
D* (cm·cps <sup>1/2</sup> /watt) (500, 90)	6.4 × 10 <sup>9</sup>
Responsive time constant (μsec)	1.4 × 10 <sup>-2</sup>
$\frac{R_{\lambda max}}{R_{bb}}$	4.1
Peak wavelength (μ)	4.1
Peak detective modulation frequency (cps)	> 4 × 10 <sup>3</sup>
D* <sub>nm</sub> (cm·cps <sup>1/2</sup> /watt)	3.3 × 10 <sup>10</sup>

# CELL DESCRIPTION

Type	PbSe (chem.)
Shape of sensitive area (cm)	0.25 × 0.25
Area (cm <sup>2</sup> )	6.25 × 10 <sup>-2</sup>
Dark resistance (ohms)	3.5 × 10 <sup>5</sup>
Dynamic resistance (ohms)	---
Field of view	53°
Window material	Si (coated)

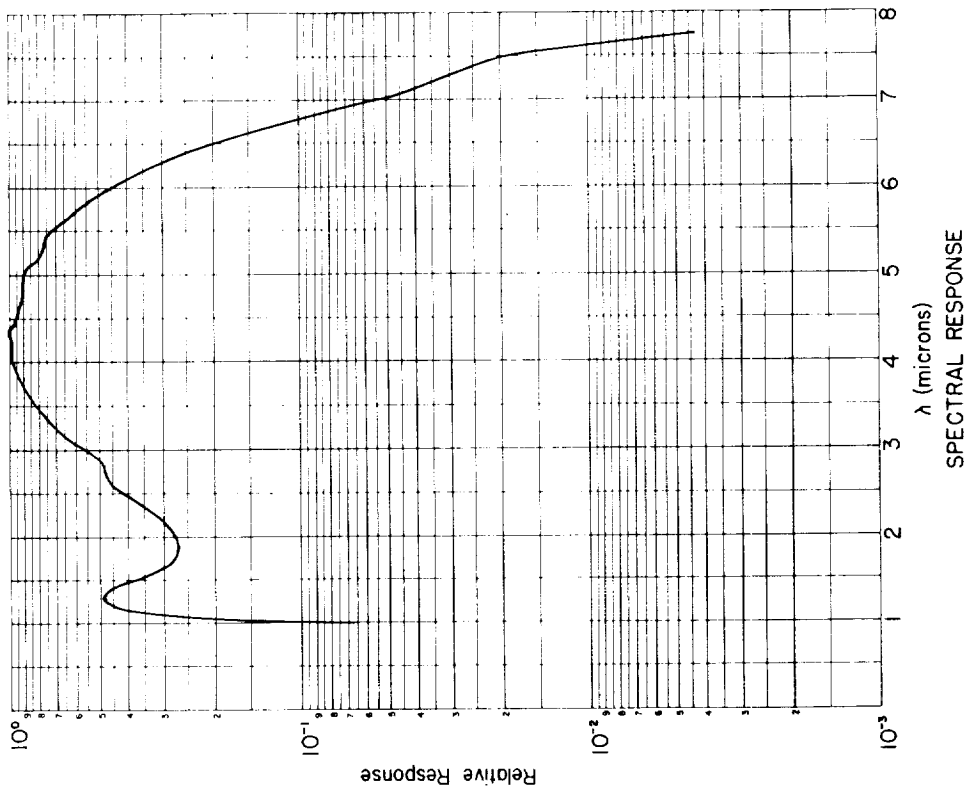


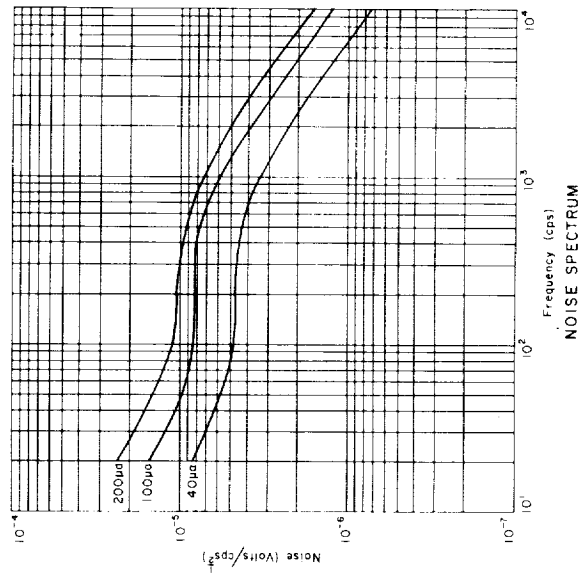
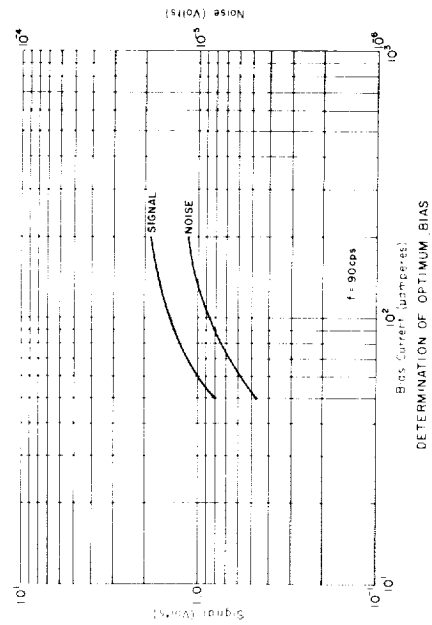
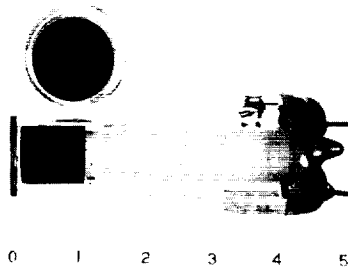
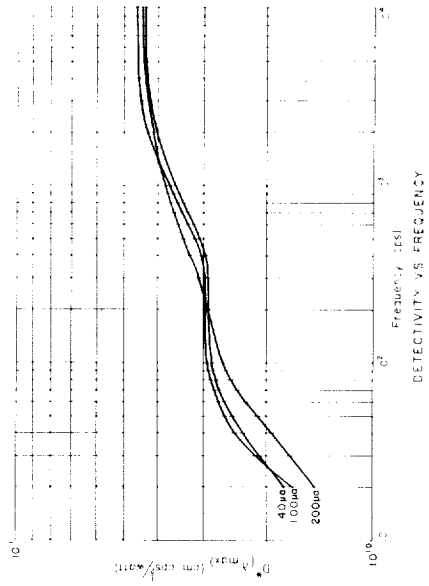
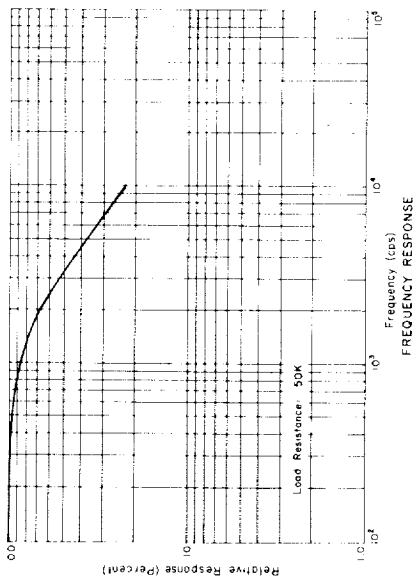
# TEST RESULTS

R (volts/watt) (500, 90)	$2.4 \times 10^5$
H <sub>N</sub> (watts/cps <sup>1/2</sup> ·cm <sup>2</sup> ) (500, 90)	$5.4 \times 10^{-10}$
P <sub>N</sub> (watts/cps <sup>1/2</sup> ) (500, 90)	$3.3 \times 10^{-11}$
D* (cm-cps <sup>1/2</sup> /watt) (500, 90)	$7.5 \times 10^9$
Responsive time constant (μsec)	84
$\frac{R_{\lambda, \max}}{R_{bb}}$	4.1
Peak wavelength (μ)	4.4
Peak detective modulation frequency (cps)	$> 4 \times 10^3$
D* <sub>mm</sub> (cm-cps <sup>1/2</sup> /watt)	$4.5 \times 10^{10}$

## CELL DESCRIPTION

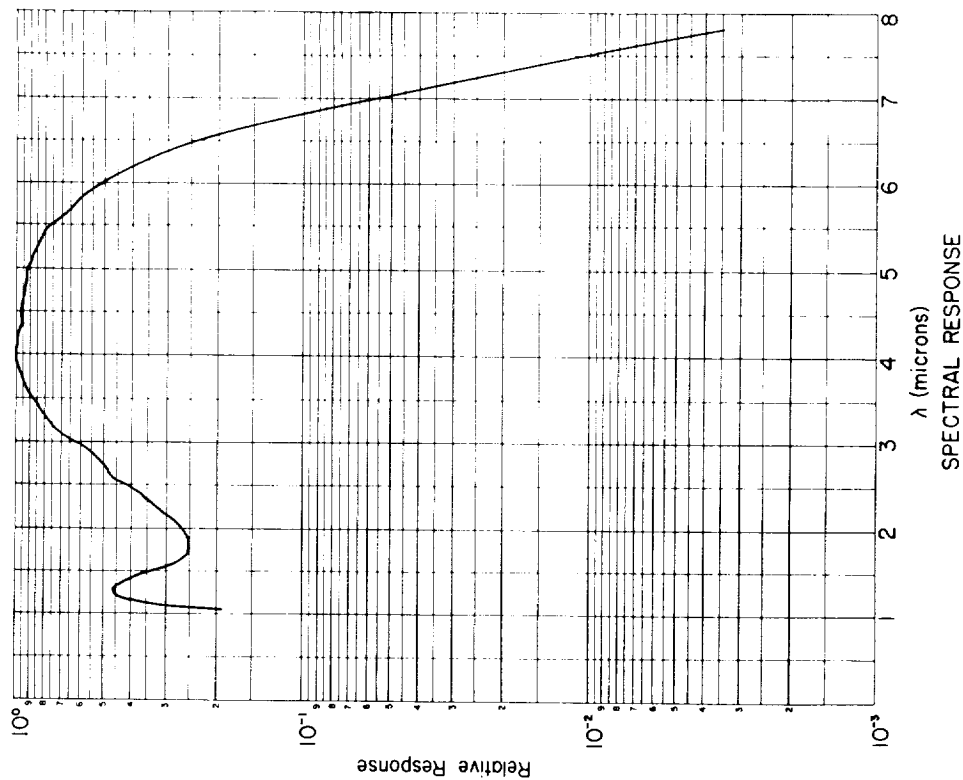
Type	PbSe (chem.)
Shape of sensitive area (cm)	0.25 × 0.25
Area (cm <sup>2</sup> )	$6.25 \times 10^{-2}$
Dark resistance (ohms)	$2.3 \times 10^5$
Dynamic resistance (ohms)	---
Field of view	5°
Window material	Silicon

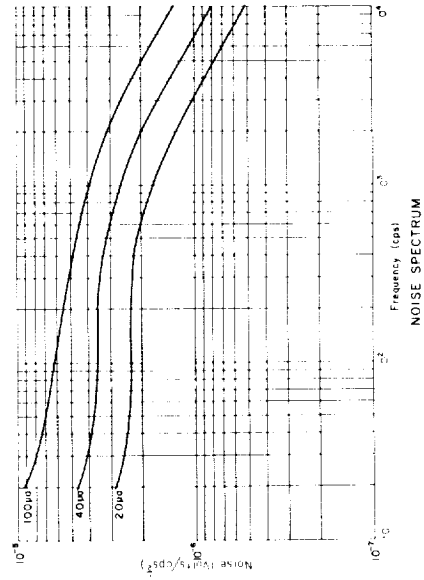
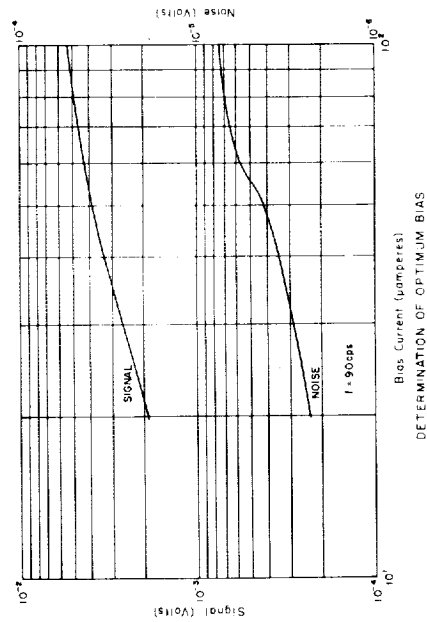
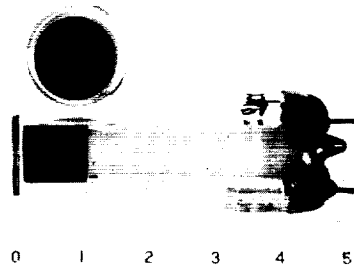
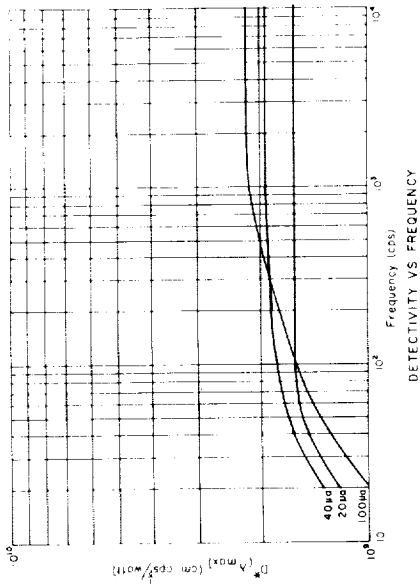
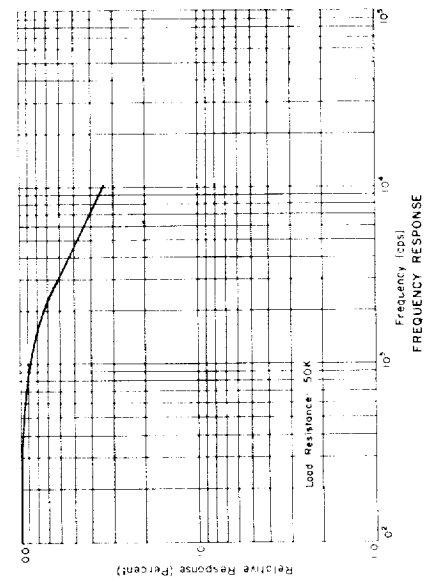




# TEST RESULTS

R (volts/watt) (500, 90)	$2.5 \times 10^{-5}$	CONDITIONS OF MEASUREMENT	
$H_N$ (watts/cps $^2$ .cm $^2$ ) (500, 90)	$5.5 \times 10^{-10}$	Blackbody temperature (°K)	500
$P_N$ (watts/cps $^2$ ) (500, 90)	$3.4 \times 10^{-11}$	Blackbody flux density (μ-watts/cm $^2$ , rms)	9.0
$D^*$ (cm-cps $^{1/2}$ /watt) (500, 90)	$7.3 \times 10^9$	Chopping frequency (cps)	90
Responsive time constant (μsec)	85	Noise bandwidth (cps)	5
$\frac{R_{\lambda max}}{R_{bb}}$	3.9	Cell temperature (°K)	78
Peak wavelength (μ)	4.0	Cell current for 90-cps data (μa)	100
Peak detective modulation frequency (cps)	$> 4.0 \times 10^3$	Cell current for $D^*$ mm (μa)	100
$D^*$ mm (cm-cps $^{1/2}$ /watt)	$4.3 \times 10^{10}$	Load resistance (ohms)	$1.0 \times 10^6$
CELL DESCRIPTION		Transformer	---
Type	PbSe (chem.)	Relative humidity (%)	36
Shape of sensitive area (cm)	$0.25 \times 0.25$	Responsive plane (from window)	---
Area (cm $^2$ )	$6.25 \times 10^{-2}$	Ambient temperature (°C)	24
Dark resistance (ohms)	$2.0 \times 10^6$	Ambient radiation on detector	297 K
Dynamic resistance (ohms)	---		
Field of view	53°		
Window material	Silicon		

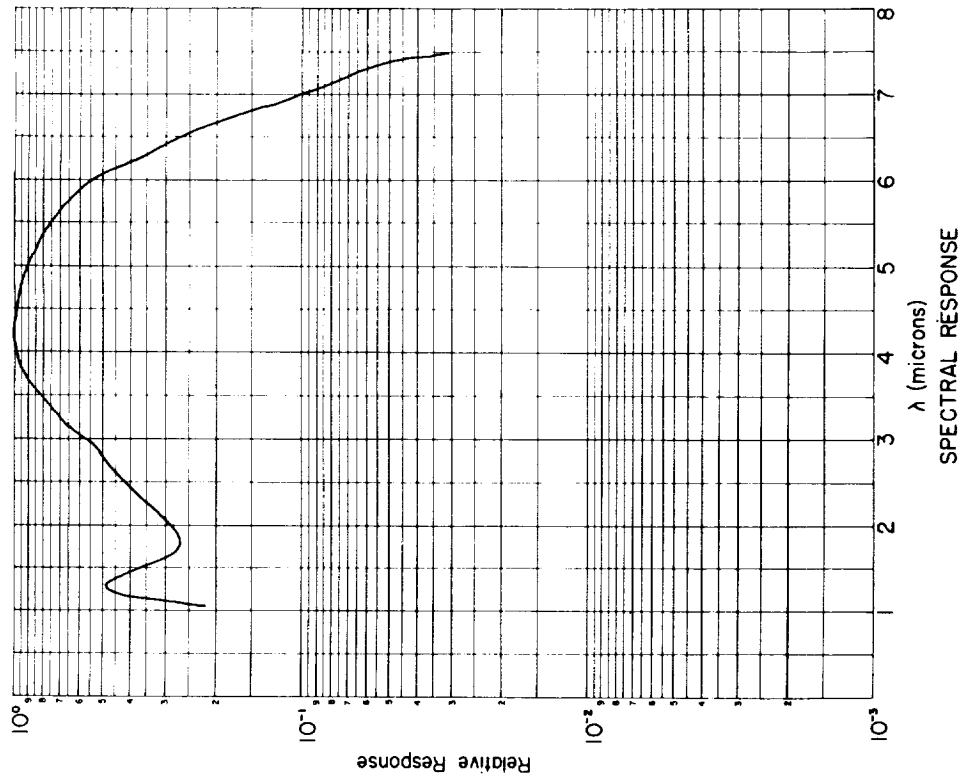


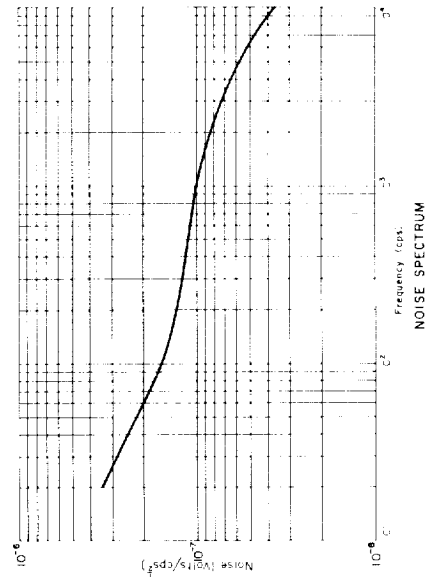
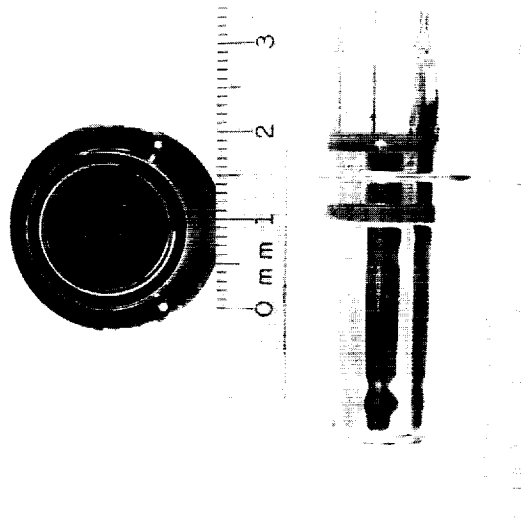
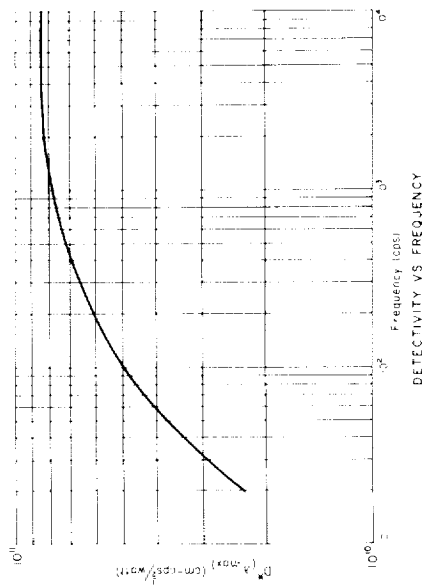
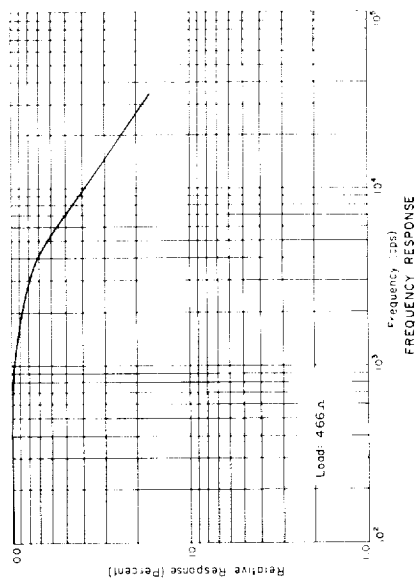


Santa Barbara Research Center, Cell 4002-11-31

DATA SHEET NO. 740-A—April 1962

TEST RESULTS		CONDITIONS OF MEASUREMENT	
R (volts/watt) (500, 90)	$5.8 \times 10^{-5}$	Blackbody temperature (°K)	500
$H_N$ (watts/cps $^{\frac{1}{2}}$ .cm $^2$ ) (500, 90)	$9.7 \times 10^{-9}$	Blackbody flux density (μwatts/cm $^2$ , rms)	9.0
$P_N$ (watts/cps $^{\frac{1}{2}}$ ) (500, 90)	$6.0 \times 10^{-12}$	Chopping frequency (cps)	90
$D^*$ (cm-cps $^{\frac{1}{2}}$ /watt) (500, 90)	$4.2 \times 10^9$	Noise bandwidth (cps)	5
Responsive time constant (μsec)	72	Cell temperature (°K)	78
$\frac{R_{\lambda, \max}}{R_{bb}}$	4.4	Cell current for 90-cps data (μa)	40
Peak wavelength (μ)	4.3	Cell current for $D^*_{mm}$ (μa)	100
Peak detective modulation frequency (cps)	$> 2 \times 10^3$	Load resistance (ohms)	$5.0 \times 10^5$
$D^*_{mm}$ (cm-cps $^{\frac{1}{2}}$ /watt)	$2.1 \times 10^{10}$	Transformer	---
CELL DESCRIPTION		Relative humidity (%)	35
Type	PbSe (chem.)	Responsive plane (from window)	---
Shape of sensitive area (cm)	$0.025 \times 0.025$	Ambient temperature (°C)	24
Area (cm $^2$ )	$6.25 \times 10^{-4}$	Ambient radiation on detector	297°K
Dark resistance (ohms)	$3.8 \times 10^5$		
Dynamic resistance (ohms)	---		
Field of view	90°		
Window material	Silicon		





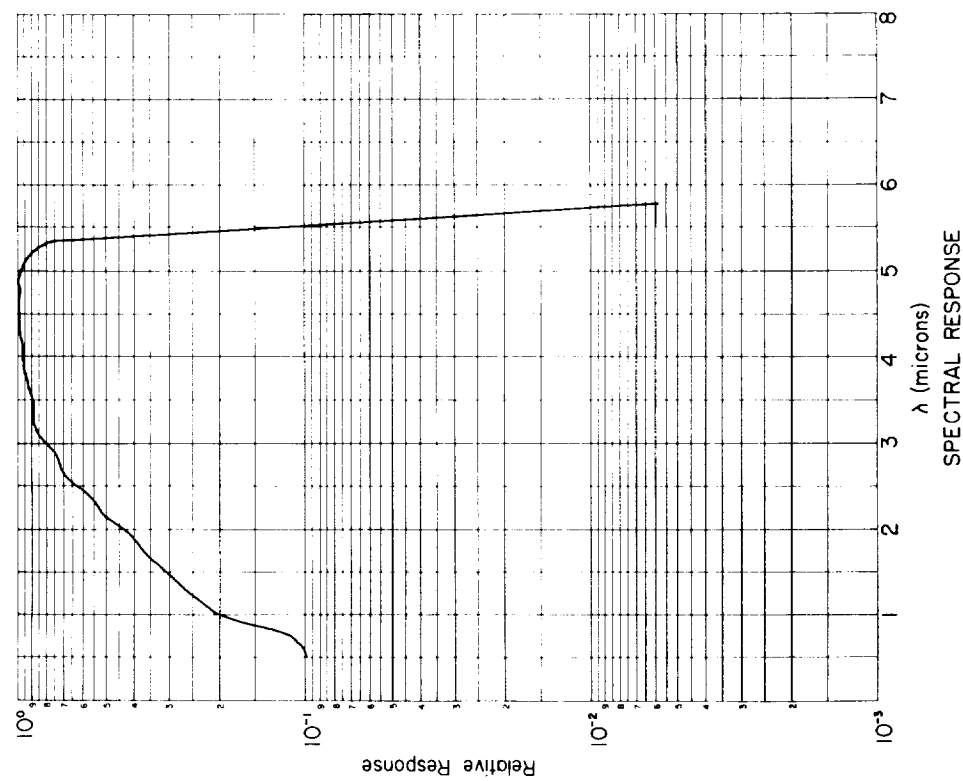
Philco Corporation Cell, InSb

DATA SHEET NO. 741-A—March 1962

# TEST RESULTS

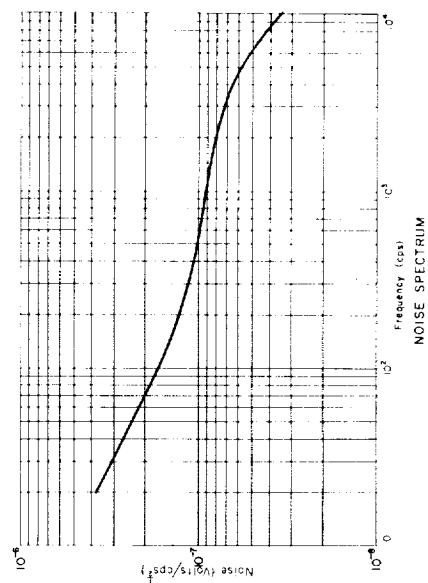
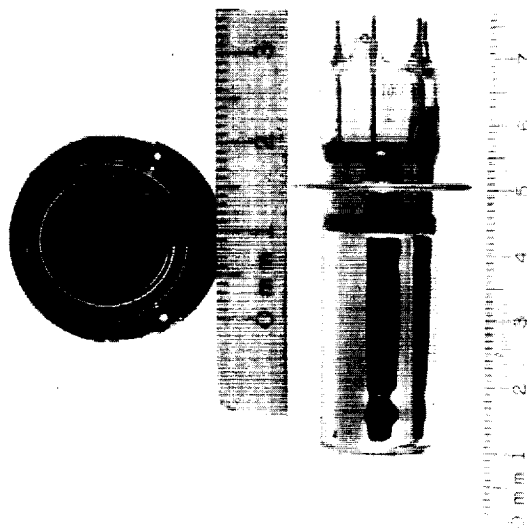
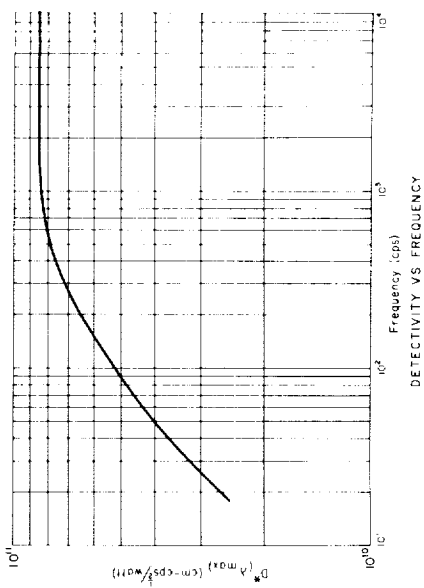
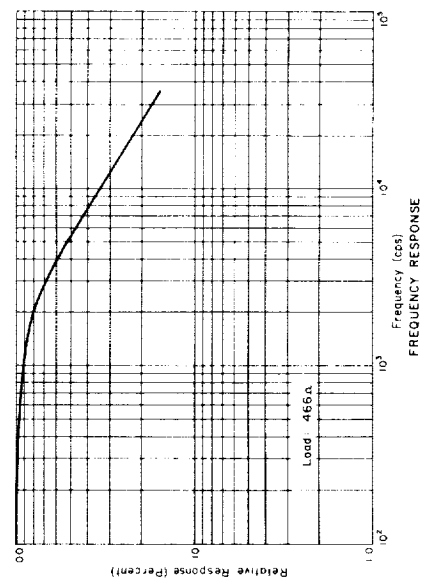
## CONDITIONS OF MEASUREMENT

R (volts/watt) (500, 90)	$6.3 \times 10^{-3}$	Blackbody temperature (°K)	500
H <sub>N</sub> (watts/cps <sup>1/2</sup> ·cm <sup>2</sup> ) (500, 90)	$4.7 \times 10^{-10}$	Blackbody flux density (μwatts/cm <sup>2</sup> , rms)	9.0
P <sub>N</sub> (watts/cps <sup>1/2</sup> ) (500, 90)	$2.6 \times 10^{-11}$	Chopping frequency (cps)	90
D* (cm-cps <sup>1/2</sup> /watt) (500, 90)	$9.1 \times 10^9$	Noise bandwidth (cps)	5
Responsive time constant (μsec)	39	Cell temperature (°K)	78
$\frac{R_{\lambda\max}}{R_{bb}}$	5.3	Cell current for 90-cps data (μa)	---
Peak wavelength (μ)	4.8	Cell current for D* <sub>mm</sub> (μa)	---
Peak detective modulation frequency (cps)	$> 10^3$	Load resistance (ohms)	---
D* <sub>mm</sub> (cm-cps <sup>1/2</sup> /watt)	$8.3 \times 10^{10}$	Transformer	Geofomer G-5 466-11 prim.
CELL DESCRIPTION			
Type	InSb (crystal)	Relative humidity (%)	34
Shape of sensitive area (cm)	0.22 x 0.25	Responsive plane (from window)	---
Area (cm <sup>2</sup> )	$5.5 \times 10^{-2}$	Ambient temperature (°C)	23
Dark resistance (ohms)	---	Ambient radiation on detector	290 K only
Dynamic resistance (ohms)	$1.0 \times 10^4$		
Field of view	---		
Window material	Sapphire		

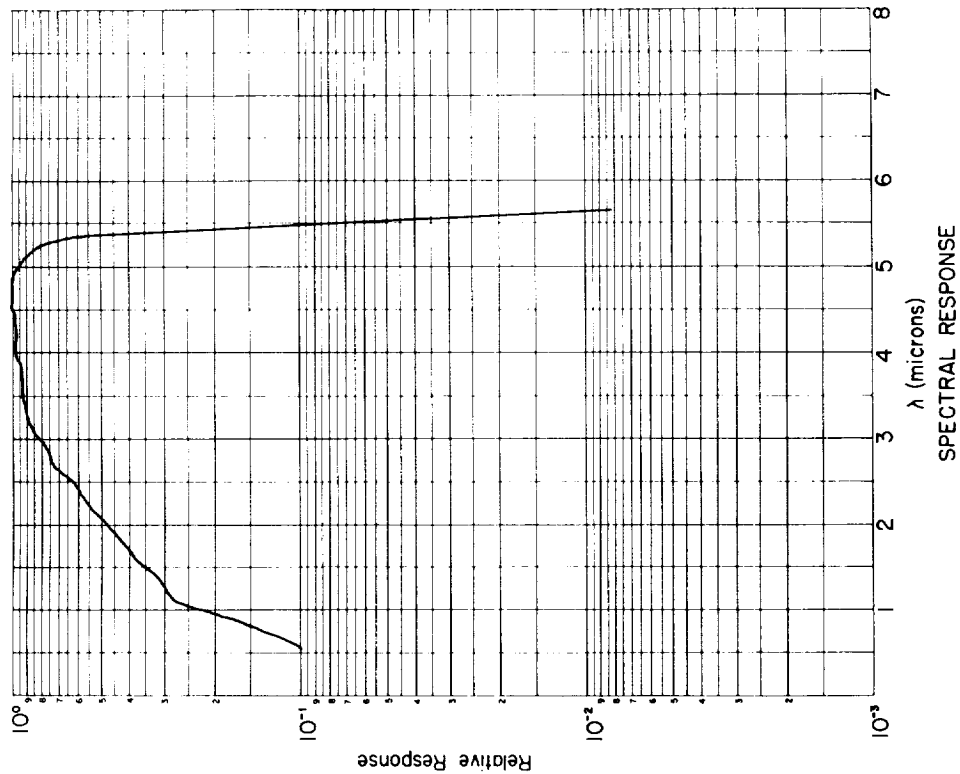


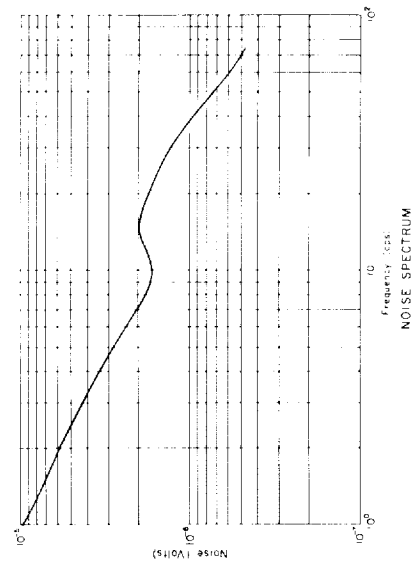
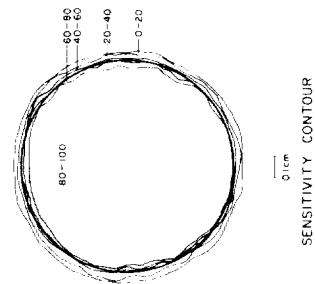
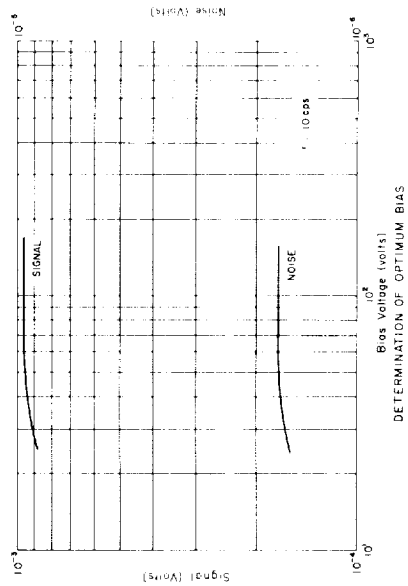
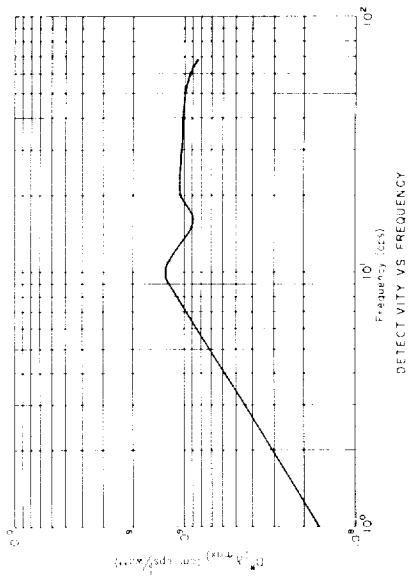
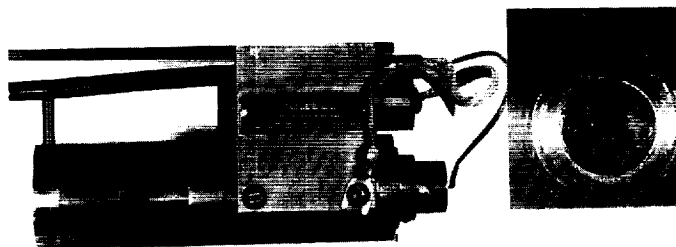
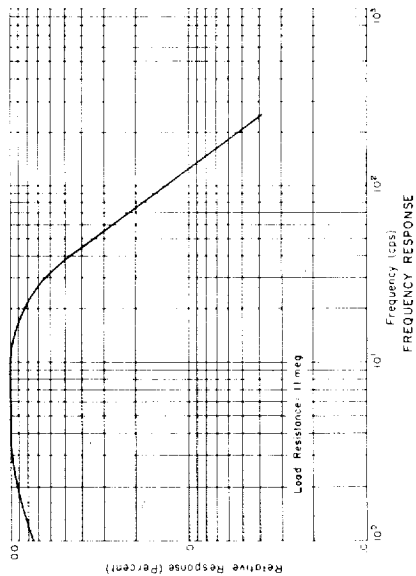
Philco Corporation Cell, InSb

DATA SHEET NO. 741-B—March 1962



TEST RESULTS		CONDITIONS OF MEASUREMENT	
R (volts/watt) (500, 90)	$8.4 \times 10^{-3}$	Blackbody temperature (°K)	500
$H_N$ (watts/cps $^{\frac{1}{2}}$ ·cm $^2$ ) (500, 90)	$5.7 \times 10^{-10}$	Blackbody flux density (μwatts/cm $^2$ , rms)	9.0
$P_N$ (watts/cps $^{\frac{1}{2}}$ ) (500, 90)	$2.0 \times 10^{-11}$	Chopping frequency (cps)	90
$D^*$ (cm·cps $^{\frac{1}{2}}$ /watt) (500, 90)	$9.3 \times 10^9$	Noise bandwidth (cps)	5
Responsive time constant (μsec)	57	Cell temperature (°K)	78
$\frac{R_{\lambda_{max}}}{R_{bb}}$	5.3	Cell current for 90-cps data (μa)	---
Peak wavelength (μ)	4.8	Cell current for $D^*$ (μa)	---
Peak detective modulation frequency (cps)	$> 10^3$	Load resistance (ohms)	---
$D^*$ mm (cm·cps $^{\frac{1}{2}}$ /watt)	$8.3 \times 10^{10}$	Transformer 466-G prim.	---
CELL DESCRIPTION		Relative humidity (%)	34
Type	InSb (crystal)	Responsive plane (from window)	---
Shape of sensitive area (cm)	$0.14 \times 0.25$	Ambient temperature (°C)	23
Area (cm $^2$ )	$3.5 \times 10^{-2}$	Ambient radiation on detector	29° K only
Dark resistance (ohms)	---		
Dynamic resistance (ohms)	$1.5 \times 10^4$		
Field of view	---		
Window material	Sapphire		

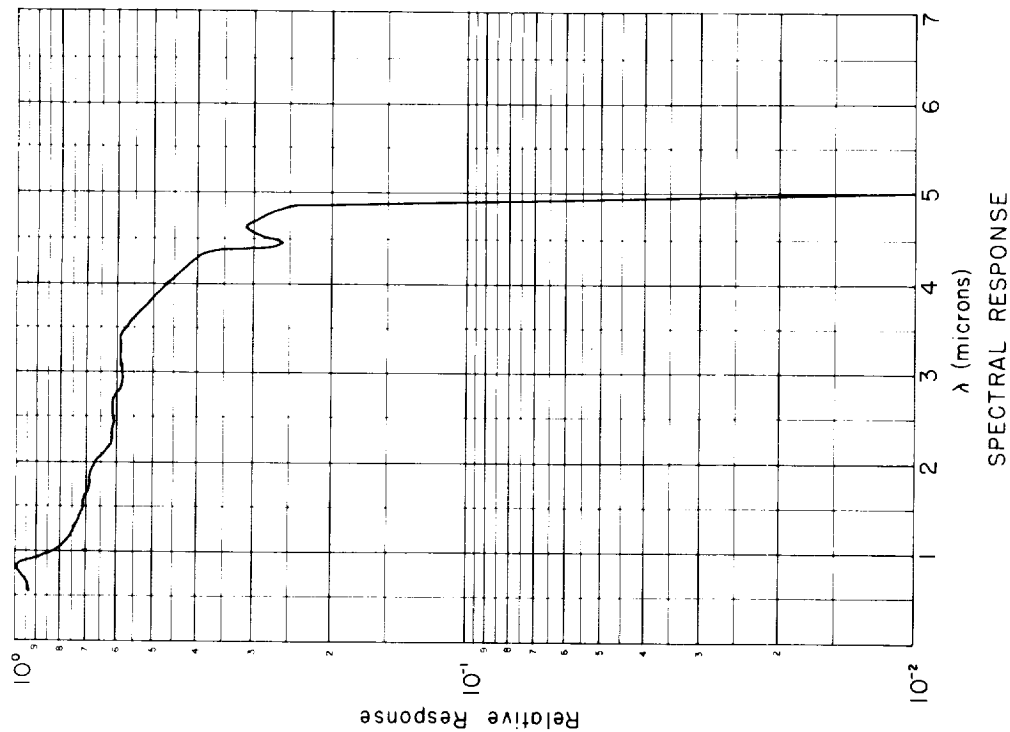


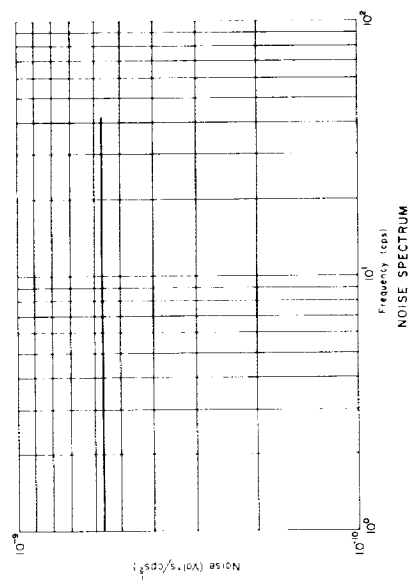
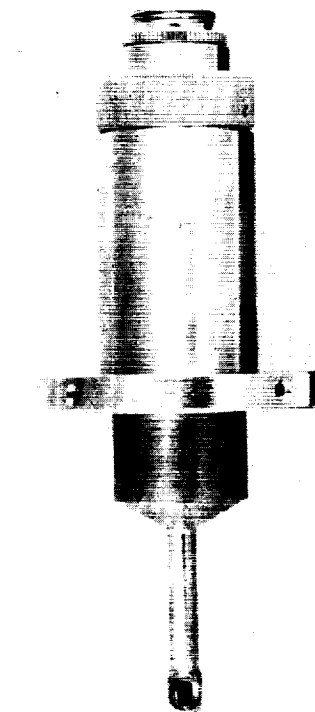
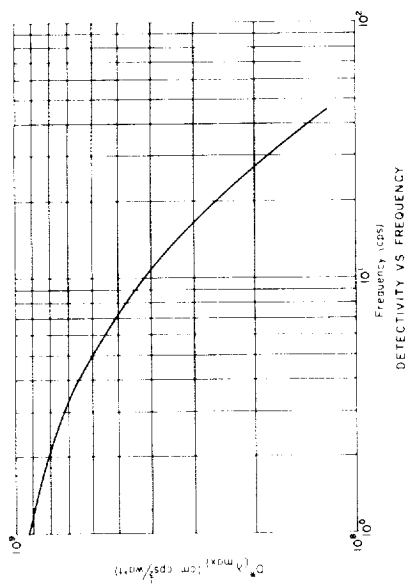
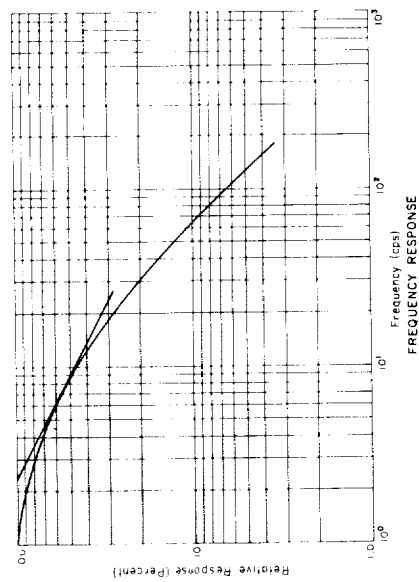


Eppley Laboratory, Inc., Cell 786, Golay det.  
DATA SHEET NO. 743-A—March 1962

# TEST RESULTS \* CONDITIONS OF MEASUREMENT

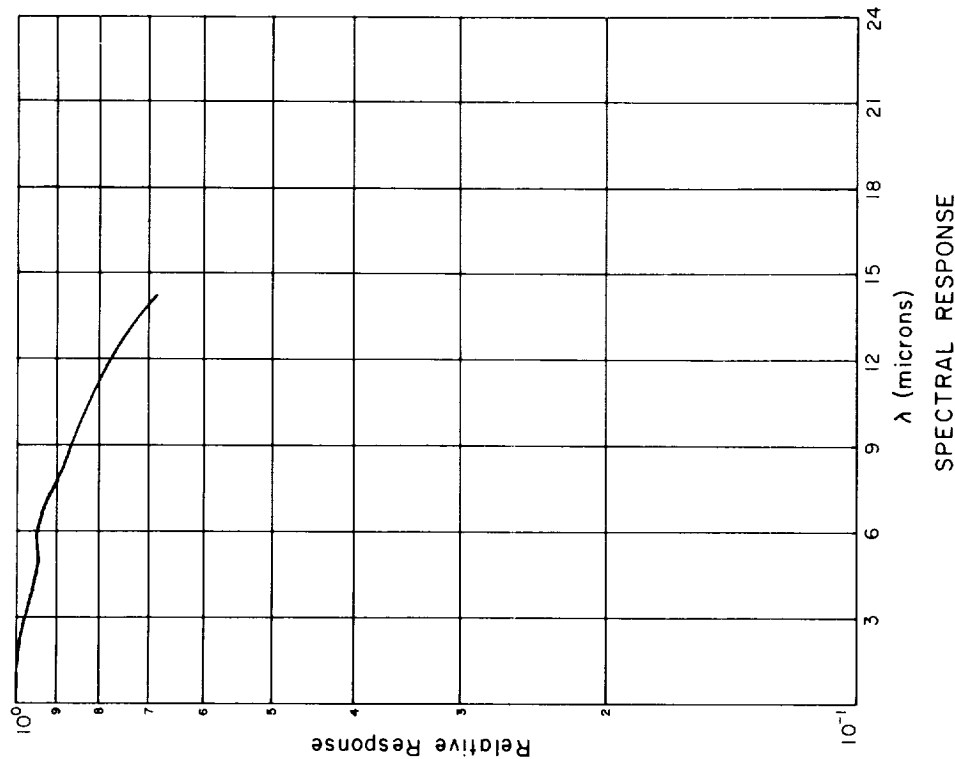
R (volts/watt) (500, 10)	$1.5 \times 10^{-2}$	Blackbody temperature (°K)	500
H <sub>N</sub> (watts/cps <sup>1/2</sup> ·cm <sup>2</sup> ) (500, 10)	$1.5 \times 10^{-8}$	Blackbody flux density (μwatts/cm <sup>2</sup> , rms)	9.0
P <sub>N</sub> (watts/cps <sup>1/2</sup> ) (500, 10)	$1.1 \times 10^{-8}$	Chopping frequency (cps)	10
D* (cm·cps <sup>1/2</sup> /watt) (500, 10)	$7.7 \times 10^7$	Noise bandwidth (cps)	0.3
Responsive time constant (μsec)	$5.7 \times 10^{-3}$	Cell temperature (°K)	297
$\frac{R_{\lambda\max}}{R_{bb}}$	16	Cell voltage for 10-cps data (v)	100
Peak wavelength (μ)	0.8	Cell voltage for D* <sub>mm</sub> (v)	100
Peak detective modulation frequency (cps)	10	Load resistance (ohms)	$1.1 \times 10^7$
D* <sub>mm</sub> (cm·cps <sup>1/2</sup> /watt)	$1.2 \times 10^9$	Transformer	---
		Relative humidity (%)	30
		Responsive plane (from window)	---
		Ambient temperature (°C)	24
		Ambient radiation on detector	297°K only
		*These data are referred to an 11-megohm load resistor. They are not open circuit values.	
Dark resistance (ohms)	$> 5.0 \times 10^7$		
Dynamic resistance (ohms)	---		
Field of view	---		
Window material	Quartz		





Perkin Elmer Corp., Cell 9770, Thermocouple  
DATA SHEET NO. 744-A—April 1962

TEST RESULTS		CONDITIONS OF MEASUREMENT	
R (volts/watt) (500, 10)	3.0	Blackbody temperature (°K)	500
H <sub>N</sub> (watts/cps <sup>1/2</sup> ·cm <sup>2</sup> ) (500, 10)	4.5 × 10 <sup>-8</sup>	Blackbody flux density (μwatts/cm <sup>2</sup> , rms)	9.0
F <sub>N</sub> (watts/cps <sup>1/2</sup> ) (500, 10)	1.8 × 10 <sup>-10</sup>	Chopping frequency (cps)	10
D* (cm·cps <sup>1/2</sup> /watt) (500, 10)	3.5 × 10 <sup>8</sup>	Noise bandwidth (cps)	0.3
Responsive time constant (μsec)	1.9 × 10 <sup>-4</sup>	Cell temperature (°K)	297
R <sub>λmax</sub> R <sub>bb</sub>	1.2	Cell current for 10-cps data (μa)	---
Peak wavelength (μ)	1.0	Cell current for D* mm (μa)	---
Peak detective modulation frequency (cps)	1.0	Load resistance (ohms)	---
D* mm (cm·cps <sup>1/2</sup> /watt)	9.1 × 10 <sup>8</sup>	Transformer Triad, G95046 10 Ω; 1 meg	
CELL DESCRIPTION		Relative humidity (%)	30
Type	Thermocouple	Responsive plane (from window)	---
Shape of sensitive area (cm)	0.02 × 0.2	Ambient temperature (°C)	24
Area (cm <sup>2</sup> )	4 × 10 <sup>-3</sup>	Ambient radiation on detector	297°K only
Dark resistance (ohms)	---		
Dynamic resistance (ohms)	16		
Field of view	---		
Window material	CsI		



## APPENDIX

### DEFINITIONS OF SYMBOLS AND TERMS

$A$  = adopted sensitive area of the detector in  $\text{cm}^2$

$f$  = modulation frequency of the radiation incident on the detector

$\Delta f$  = frequency bandwidth of the electrical measuring system  
in cps

$J$  = rms value of the fundamental component of the radiant  
energy flux density, in  $\text{watts/cm}^2$

$N$  = rms noise voltage

$R_0$  = maximum response

$R_\omega$  = response as a function of  $\omega = 2\pi f$

$\frac{R_{\lambda_{\text{max}}}}{R_{\text{bb}}} =$  ratio of the responsivity at the peak wavelength to  
the responsivity to blackbody radiation

$V$  = rms value of the fundamental component of the signal voltage  
as measured with the entire surface of the detector exposed

$T$ , responsive time constant. When the photon-excited carriers in the semiconductor have a simple decay mechanism, the response to a sinusoidal varying signal may be given by

$$R_\omega/R_0 = (1 + \omega^2 T^2)^{-\frac{1}{2}}$$

The responsive time constant ( $T$ ) is calculated from the frequency response. It will be noted that the load resistance used in each case is given on the frequency response curve.

$R$ . The responsivity ( $R$ ) is defined as the ratio of the rms value of the fundamental component of the signal voltage to the rms value of the fundamental component of the incident radiation power:

$$R = V/JA$$

The units of  $R$  are volts/watt.

$H_N$ . The noise equivalent irradiance ( $H_N$ ) is defined as the minimum radiant flux density necessary to give a signal-to-noise ratio of 1 when the noise is normalized to unit bandwidth:

$$H_N = JN/V \cdot \Delta f^{\frac{1}{2}}$$

The units of  $H_N$  are watts/cps $^{\frac{1}{2}}$ ·cm $^2$ .

$P_N$ . The noise equivalent power ( $P_N$ ) is defined as the minimum radiant flux necessary to give a signal-to-noise ratio of 1 when the noise is normalized to unit bandwidth:

$$P_N = JNA/V \cdot \Delta f^{\frac{1}{2}}$$

The units of  $P_N$  are watts/cps $^{\frac{1}{2}}$ .

$D^*$ . D-star is defined<sup>1</sup> as the detectivity normalized to unit area and unit bandwidth. Detectivity is the signal-to-noise ratio produced with unit radiant flux incident on the detector:

$$D^* = A^{\frac{1}{2}}/P_N$$

The units of  $D^*$  are cm·cps $^{\frac{1}{2}}$ /watt.

$D^*_{mm}$  is defined as D-star at the peak wavelength, the optimum bias value, and the peak detective modulation frequency.

Calibration. The gain of the electrical system is calibrated by injecting a known voltage in series with the detector being tested. This is accomplished by means of a small resistor placed between the detector ground terminal and the system ground. Thus, the detector signal and noise voltages are referred to the detector terminals and to an infinite load impedance. The detector noise is corrected for amplifier noise.

---

<sup>1</sup>R. Clark Jones, "Methods of Rating the Performance of Photoconductive Cells," Proceedings of IRIS, Vol. 2, No. 1, June 1957.

## INITIAL DISTRIBUTION

### Standard Photodetector Distribution List (258)

#### NOLC:

C. J. Humphreys, Code 40	1
R. F. Potter, Code 43	1
W. L. Eisenman, Code 431	1
J. D. Merriam, Code 431	1
A. B. Naugle, Code 431	1
J. Bernstein, Code 432	1
J. J. Nastronero, Code 54	1
Technical Library, Code 234	2



